Programed Instruction

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Inside Opinion

QUESTION: How does a program differ from a standard workbook?

ANSWER: A program is a self-contained sequence of instructional items which can be presented to individual students under controlled conditions. It is designed specifically to teach material and is repeatedly tested and revised until it gives consistent and acceptable results.

The items in a standard workbook provide practice on material taught elsewhere. A workbook is not designed to do a teaching job. Applying some programing techniques, however, might result in making a workbook a good deal more efficient. An item analysis of students' responses would probably lead the author to rewrite a number of unnecessarily confusing items. It might also show up unsuspected areas of ignorance for which new practice exercises could be written. The attempt to give students more adequate preparation for the components of each new exercise might suggest changes in the order of the exercises.

If this process of revision were repeated, under adequately controlled conditions, the workbook might eventually approximate a program of instruction. The contrast between such a "programed workbook" and the more usual "programed textbook" might help to break us free from the notion that all programs must consist of sequences of sentences with words left out.

Wells Hively

Research Fellow, Teaching Machine Project, Harvard University Psychological Laboratories. Author of articles pertaining to the field of teaching machines and programed instruction.

ANSWER: Aside from the obvious differences — the meticulous analysis of behavior prior to preparation of a program, the application of behavioral principles of stimulus control, and so on, there is the overriding difference concerning the assumption of the responsibility for whether or not the student learns. Although I must quickly disqualify myself as an expert in conventional workbooks, it seems clear that workbook writers assume about the same amount of responsibility for the student's behavior as textbook writers do. All of us reading this Bulletin have learned from conventional workbooks and from conventional textbooks. If the appropriate behavior is in the student's repertoire, everything is fine. If it is not, nothing happens, except that extinction occurs.

That the two approaches differ in the order

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Ring Out, Wild Bells . . . . .

Read all about it! See it now! Learn by doing! Let's stay experimental! These were recurring themes in programing as the academic year got into full swing. Highly informative articles on the field appeared in the fall issues of a number of popular professional periodicals. The National Education Association included a special journal feature on teaching machines and programed learning in its November issue. In the November *Scientific American* a wonderfully illustrated article by B. F. Skinner related the language of the laboratory to the art of pedagogy; at the same time readers of the November 18th issue of the *Saturday Review of Literature* were being taken "Inside the Teaching Machine" by Susan Meyer Markle. For those who were concerned with the subtle issues involved in "Evaluating Teaching Machines and Programs," James Holland's article in the October issue of the *Teachers College Record* provided much food for thought.

The American Management Association, Educational Records Bureau, and Purdue University conferences on programed instruction and teaching machines provided a wide range of speakers to hear, and models of machines to see. One of the most interesting was a device, using microfilmed programs, to retail for $80 to $90. A major commercial concern which has been selling programs door to door introduced its new division for marketing programs to schools. A real treat for the Purdue Conference goers was the opportunity to hear S. L. Pressey, "grandfather" of the teaching machine movement.

School systems, large and small, urban and rural, provided one-day workshops and speakers to introduce their faculty, parents, and school board members to programed instruction.

A Saturday morning in-service workshop for 80 faculty members was recently completed by the Bethlehem Central School System in Delmar, New York. Five two-hour sessions were held under the tutelage of Dr. John Blyth of Hamilton College.

"Workshop Revisited" will be the theme when Oregon College of Education plays host for two days in January to the participants in its summer workshop in programed instruction. Dr. Evan Keislar and Dr. Harry Silberman will likely be at the helm again.

The Center, to date, has received 31 requests from colleges to conduct workshops similar to those offered last summer. Soon to be announced—the Center's summer institutes to train faculty who in turn will conduct workshops and in-service courses in their respective academic communities.

A steady flow of reports on research and use of programed materials continues to be received at the Center. The Baltimore County Public Schools reported on the first year of a three-year study carried on in cooperation with the University of Virginia and involving 340 elementary school children. Fourth graders in six elementary schools worked through an arithmetic program designed in a linear, constructed-response, ruleg mode, and written by the school system's teachers. A second exposure to the materials was provided. "The experimental treatment did not in itself handicap the progress of individuals or groups of pupils in arithmetic." This year the same students will work on a program in 5th grade arithmetic.

The Baldwin-Whitehall School District, located outside of Pittsburgh, has started on a five-year study exploring implementation of programed materials at the junior high school level. Dr. Robert Glaser of the University of Pittsburgh's Psychology Department is directing the project for the U.S. Office of Education. Approximately five hundred 7th and 8th graders in two junior high schools are "testing and digesting" generally accepted 9th grade general science materials. Administrators quote as "highly favor-

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Quotable Quotes

"Programed learning offers considerable promise as a means of breaking a serious bottleneck in introducing new subject matter into the curriculum. Let me refer, for example, to the current revolution in mathematics. The bottleneck in this instance is the re-education of teachers. Under present conditions, the new mathematics cannot possibly be introduced into the curriculum of a particular school until the teachers understand the changes in content and methodology which are involved. Most of the new systems of instruction such as the U.I.C.S.M. and S.M.S.G., recognize the necessity of teacher education and will not normally make their materials available to schools unless the teachers involved undergo a period of orientation. What with the ever present problem of teacher turnover, this makes the introduction of modern mathematics tortuously slow. If much of modern mathematics can be programed, and there already is evidence that it can be, then one of the major bottlenecks may be broken.

It seems to be increasingly evident, therefore, that the major responsibility for the future of programed learning rests primarily with public school educators like myself. We cannot afford to wait for the academic schools, the professors of education or our professional associates to tell us what to do. We must take the initiative, for if we don't it will be seized by others less qualified than we are to decide what should happen in the schools."

J. Bernard Everett

Assistant Superintendent of Schools, Division of Instruction, Newton, Mass., from a paper delivered at the Frontiers of Science Conference, Oklahoma City, February, 1961.

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Editor

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Responses

(This month's responses were received from the Director of the project using programed materials in Roanoke City Public Schools, Roanoke, Virginia last spring. When asked "Can and should teachers write programs?" the Director in turn asked a number of teachers involved in field trials of the materials. These teachers replies are presented not as an endorsement for a particular method of developing programed materials, but as the viewpoints of one group of teachers, who used materials developed by one method.)

We agree that the subject matter specialists should continue to do the basic work in preparing the programs. Surely no teacher should be expected to prepare his own program. However, we feel that teachers who have actually had classroom teaching in a particular subject should review the material before it is put in the classroom.

Margaret Fisher
Berta Hartman
Florence Stump

In my opinion subject matter specialists should prepare the programed material for high school courses. It is a task far too time consuming for any high school teacher. A broad knowledge of the subject matter together with the psychological know-how of presenting it is necessary. Obviously, then, good programs must be produced by specialists in the field. Teachers may be able to give helpful suggestions for revision of the materials they have used or are using.

Mabel Noell

One using programed materials will develop the ability to perform mathematical operations skillfully and with understanding. The learner is also provided with a rich variety of experiences to assure individual success. If these objectives are to be achieved, the materials used should be the findings of most recent research. This I believe can be done effectively by specialists. Because the teacher has daily contacts with the use of this material, her role in the total evaluation cannot and must not be minimized. Her critical analyses will be invaluable to the specialist, in his preparation, in meeting the needs of the individual for further programing.

Dorothy D. Witten

INSIDE OPINION

(Continued from page 1)

of teaching power is, I believe, attested to by the fact that there is now in existence, all observers agree, a "teaching machine movement." Again, although I am not a workbook expert, I can recall no "workbook movement" being generated.

But the only really definitive test of the difference between a workbook and a program is, in the final analysis, the differences in the effects they have on student behavior.

Lloyd E. Homme

President, Teaching Machines Incorporated, Albuquerque, New Mexico. Pioneer author, researcher of programed instructional materials and teaching machines.

Teaching Plane Geometry by the use of the programed materials as prepared by the specialists in the field has been gratifying. The course is desirably planned; it is very inclusive in the choice of subject matter—intensive and extensive. The average classroom teacher would not have the time to perform the task as effectively as it has been done and neither could she make the improvements as rapidly as they are being incorporated. The teacher needs her time for other teaching duties that are uniquely hers. It is hoped that the programed materials will continue to be prepared by the specialists just as textbooks are now being written.

Ella M. Keen

Previous to the use of the experimental mathematics this year, I had been convinced that experienced teachers were the ones best informed and most able to prepare programed materials. After having used several of the mathematics programed textbooks, I have changed my opinion and am thoroughly convinced that the specialist in the subject matter field is superior and that the teacher's place is of considerable importance in the revision. The teacher can make constructive suggestions and I believe that the specialist and teacher together make up the best possible combination.

Martha Walden

A subject matter specialist working closely with naive subjects seems to be the best way to produce good programs. Such a specialist will be able to reword material that proves to be difficult for the student—or even approach the material from a different angle without losing sight of the objective.

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Experimentation with Programed Instruction:

Two types of experiments in programing seem to have the greatest appeal for educators: (a) the comparison of machine and textbook presentation of programed materials and (b) the comparison of programed and conventional instruction. Neither type, unfortunately, is practical or would be useful at this stage.

The machine versus textbook experiment is expensive, because machines have to be purchased or rented for the purpose; and programs usually available for machine presentation are not necessarily available in text format. More important than financial considerations is the fact that seven previous studies have shown no significant differences in learning between machine and textbook presentations of programs. In most of the studies there was a significant saving in time in favor of the programed text. These results should not be interpreted to mean that there is no purpose in investigating the efficacy of machines, but rather that research in this area should be refined.

Educators also wish to pit teachers against programs —to compare programed instruction with the "conventional method" of teaching. Comparisons between "conventional methods" and programed instruction cannot be generalized because they must reflect the competence of the particular teacher, the quality of the program used, and the evaluative instruments. In some cases the teacher who is pitted against the program is stimulated to supreme effort by the apparent threat of being replaced by a teaching machine. It is not surprising that contradictory findings evolve from such research. Programs have been found to out-teach teachers and vice versa. Even if results were clear-cut, nothing would be proved, because programed instruction is designed to be used *by* teachers.

Neither type of study can be recommended as an effective way for educators to learn *what programed instruction is* or to *determine its place* in the educational enterprise. The experimentation described here deals with ways in which interested educators can learn about unique attributes of programed materials, it does not represent CPI's views of basic research needed.

More reasonable approaches to experimenting with programed instruction include (a) Case Study, (b) Field Testing, (c) Implementation. This article explores the first two approaches.

Case Study

In the case study approach the educator examines the application of programed instruction for an individual student with a particular problem or in a particular situation. The most obvious application is for gifted and exceptional children. A 5th grade teacher may have an extremely bright student who already grasps 5th grade arithmetic. He might put the student on an advanced programed unit, like Richard Smith's *Prime Numbers and Factoring*, developed in the Newton, Massachusetts, school system. The teacher can then report on this student's reaction to working with such materials and analyze the student's performance on a posttest.

A high school teacher might be interested in trying Susan Markle's vocabulary units with a high school junior who has difficulty with words. The question to be answered is how a student, two to four years below grade level in vocabulary and reading will react to programed materials designed and tested for 8th graders.

A school or school system exploring the potential of programed instruction might have several interested teachers choose a program, then try it with a selected student, and compare their findings and observations. The success of the case study approach obviously depends upon the program selected. If it becomes apparent that the program fails to stimulate or is too difficult, teachers should not hesitate to try another program.

This approach simulates the method used by the laboratory psychologist seeking to chart the learning of a single organism. Limiting initial experimentation to one learner provides opportunity for careful attention to the entire process—from assessing the student's behavior during acquisition (examining his responses and attention span while working on the program), to measuring the terminal behavior.

Field Testing

As Ernest Rothkopf of Bell Laboratories stated at the November meetings of the Educational Records Bureau, programs should come with a "label" indicating how they have been tested and the results obtained. Even if the program selected has been tested with a group of students, much can be learned from repeating the test with part of the program in a few classroom periods. Such field testing asks: Does the program teach the content it purports to? Is the content well programed? Which students learn from it? How much time do students need to complete the program?

To assess *what* the program teaches, students must be tested after completing the program. Often, a programer-constructed test will be supplied with the program. The consumer should analyze the program to assess the adequacy of the criterion test. Careful analysis of errors, by items and by individuals, on both the program and the test, provides important insights into programing quality and individual differences.

The responses to a sequence from an entire class will reveal administrative problems: How to provide for the student who finishes in one third of the time that the slower student takes? How to deal with that portion of the class that cannot handle the program? What to do about those students who are so high on the pretest that they would not profit from the program? (For purposes of exploring the field these students *should* work the program anyway.) Does the particular unit seem more appropriate for the more able or less able students? Such

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RECENT RESEARCH

Kalin, R. Development and Evaluation of a Programed Text in an Advanced Mathematical Topic for Intellectually Superior Fifth and Sixth Grade Pupils. (Doctoral dissertation abstract) Florida State University, 1961.

This study investigated the ability of "intellectually superior" pupils to learn advanced mathematics through programed instruction.

Subject Matter:

Mathematics. "Equations and Inequalities." Programed text.

Subjects:

Ninety-five 5th- and 6th-grade students, all above average (IQ greater than 115, reading grade-placement greater than 5.0, and arithmetic grade-placement greater than 5.5). The pupils were randomly assigned to ten groups, five experimental and five control.

Procedure:

Experimental subjects read the programed text at own rate, without assistance. Control subjects were taught, with conventional methods, by teachers who were "prepared" by conferences, instruction, and study of the program. A 44-item criterion test was the evaluation instrument.

Results:

Differences in test score between paired experimental and control, were not statistically significant. Twenty per cent time saving for experimental groups. Means for these 5th and 6th graders rangers from 26.2 to 30.8 compared with a 9th grade algebra class mean of 35.0.

Comment:

The author asserts that ". . . intellectually superior fifth- and sixth-grade pupils can learn advanced mathematics from a programed text." Granted. But "intellectually superior" individuals can learn almost anything. Perhaps it would be more interesting to determine whether programed instruction can teach less gifted persons subject matter considered to be beyond their ken.

Evans, J. L., Glaser, R., and Homme, L. E., "An Investigation of 'Teaching Machine' Variables Using Learning Programs in Symbolic Logic. Department of Psychology, University of Pittsburgh, Pennsylvania. December, 1960.

This study investigated (a) the effects of differences in response modes (constructed, multiple choice, and no overt response); (b) the value of immediate reinforcement or confirmation of responses; (c) the value of a formal rule for the construction of programs.

Program:

Symbolic Logic. Two programs were constructed to teach 15 rules from the calculus of propositions. The Initial Program of 72 frames was constructed based on "standard" programing procedure. The Formal Program of 125 frames used the "ruleg" system of cue-withdrawal, in which the rule is first described with an example to be completed, then stated incompletely with the subject required to complete it, then offered in the form of an incomplete example to which it must be applied. The required terminal behavior was the use of the 15 rules to construct short deductive proofs.

Subjects:

60 University of Pittsburgh students paid $4 each for the experiment.

Procedures:

The students were randomly divided into six treatment groups.

Four groups used the Initial Program: (1) Constructed Response; (2) Multiple-Choice Response; (3) No Overt Response; (4) Reinforcement within the frame.

Two treatment groups used the Formal "ruleg" Program: (1) Constructed Response; (2) Constructed Response with a cue constantly present (a panel listing examples of the fifteen rules.).

Three tests were given: (1) True-False; (2) Performance in use of rules; (3) Performance in construction of deductive proofs by combinations of rules. Time to complete the program and time to complete tests and delayed posttest were recorded.

Results:

1) Students not required to make an overt response required less time to complete the program and scored as well on the criterion test.

2) Students in the "ruleg" formal program required significantly less time (though there were more frames in the program), and achieved roughly the same test scores as students on the less systematic program.

3) Retention was influenced by the kind of test administered. Scores on the true-false test *improved* after a week; scores on recall tests showed a small but significant drop. There was no significant change in the scores involving construction of deductive proofs.

4) Test scores did not correlate with previous mathematical experience, college class, nor with degree of retention.

Comment:

Use of Symbolic Logic as subject matter seems highly appropriate to the research. The construction of deductive proofs provides an unusually good measurement of transfer. The finding that retention varied as a function of the kind of test is extremely important to the search for criterion measures.

The comparison between the "normally" and formally constructed programs is interesting, but the results may be interpreted as displaying a weakness in the normally constructed program employed, or as a tribute to the unique suitability of Symbolic Logic for the "ruleg" approach, rather than as proof of the superiority of a formally constructed program.

With these considerations in mind, it should be pointed out that the authors have given the first existence proof that one program can be constructed by means of a formal system which will teach as effectively as a "programer constructed" program. This is an important first step in the development of programing as a science as opposed to the "technological art" that it is today.

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Alter, M., Eigen, L., and King, S. "A Preverbal Number Concept Program." Center for Programed Instruction, New York, New York. 1961.

These studies aimed to measure the efficiency of a preverbal program, under "confirmation" and "confirmation and trinkets" reinforcement conditions, with preliterate young children.

Study I

Program:

Number concept. 262 frames; multiple-choice response.

Subjects:

Sixteen children, 5 and 6 years of age, students at the Dalton School (New York City).

Procedures:

Each frame, consisting of a top or "stimulus" portion and a lower portion containing three alternate "responses," was administered to each subject individually. Subjects were required to make three types of matches: (a) *number* of objects to *number* of objects, (b) *digit* to *number* of objects, and (c) *number* of objects to *digit*. Similarity of objects and color of objects were used as cues. On the basis of a pretest (21 frames in the same format as the program), subjects were either eliminated or assigned to one of two experimental groups. Responses of "confirmation" subjects were immediately confirmed or corrected before they proceeded to the next frame. "Confirmation and trinket" subjects, in addition to this procedure, were given tiny prizes for approximately 25 per cent of their correct responses. Each subject spent three sessions of approximately 15 minutes with the program. A posttest, identical to the pretest, was administered on the day following completion of the program.

Results:

There is no significant difference between the groups on either pre- or posttest, or in the number of errors made on the program. Both groups gained approximately 9 points (statistically significant) from pretest to posttest. These results indicate that "learning" did occur; the authors feel, however, that the subjects learned to understand the test instructions rather than the number concept. Study II looked into what was learned:

Study II

Program:

Same as Study I.

Subjects:

Four children, 5 and 6 years of age, students at the Dalton School.

Procedures:

This study was run concurrently with Study I. Two students were "reinforced," and two were not. All subjects completed only the first 87 frames, which deal with numbers 1, 2, and 3, and were then given the entire posttest.

Results:

These four children, who took only the first third of the program performed on the pre- and posttest as well as the larger group who went through the entire program. The authors rightly make no attempt to generalize from these results based on minute sample sizes.

It would seem that either (a) the concept of number for the first three digits transferred remarkably well to the digits four through through nine, or (b) the subjects already knew the concepts and what they learned was how to follow instructions and to make comparisons. The authors recommend that other researchers investigating preverbal programs administer a preprogram before the experiment to teach the children how to follow instructions and make comparisons.

Comment:

These studies illustrate some of the pitfalls which are to be avoided in investigating the behavior of young children. They further point to the need for clearly defined criteria.

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Keislar, Evan R., & McNeil, John D. "Teaching Scientific Theory to First Grade Pupils by Auto-Instructional Device." University of California, Los Angeles, 1961.

This study investigated the efficacy of an instructional program in teaching first-grade children to give scientific explanations of physical phenomena.

A 432-frame program designed to teach several basic statements of molecular theory related to the processes of evaporation and condensation was presented on a Videosonic Tutor which simultaneously projected a slide upon a viewing screen and broadcasted a commentary from a tape recorder. The commentary supplied the information about each of the slides and asked multiple-choice questions. The alternative answers were presented as subpictures on the slide. After each question the pupil pressed a button corresponding to the subpicture he chose as his answer. The program did not advance until the pupil selected the correct answer.

Subjects:

Twenty-six 1st-grade pupils, divided equally into the experimental group and the control group. The two groups were matched on the basis of teacher ratings, as well as scores on a pretest of vocabulary used in the program.

Procedure:

The program was broken into 13 lessons of approximately 36 frames each. In the experimental group, each child spent approximately 15 to 20 minutes a day working on the program for a period of 13 days. Children in the control group received no special instruction. The day after the program was completed, children in both groups were given a posttest consisting of a standardized interview of about ten minutes, which, contrary to the instructional phase of the study, required the learner to say the words out loud.

Results:

1. All but one of the 13 experimental children showed higher posttest scores than did the controls, a difference which is statistically significant.

2. Success on the posttest was significantly related to the number of errors made during the instructional program (the better the performance on the program, the better the performance on the posttest).

3. There was some evidence that the program was more appropriate for children with a high reading readiness and effective study habits.

4. All the children, when asked if they would like to continue learning new things in this fashion, indicated

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Faulty Frames

Experienced programers frequently give the novice all sorts of untested advice, rules of thumb, recipes, and intuitions. The advice is based mainly on extrapolations from basic learning theory and on each programer's own discovery of what works for him. Rarely do we see a clear empirical verification in the classroom of a programing principle.

In a field as new as programing, this lack of direct evidence is to be expected rather than deplored. The "variables" which constitute a program are extremely complex, and a workable base-line program, constructed according to the extrapolated recipes, must exist before research may begin. Variations to be studied can be introduced systematically and their effects compared with the known results of the tested program. Tested programs are as yet few in number, but at least one major exception does exist. The research described herein is one of the rarities and bears on one of the most significant rules of thumb that programers know. The investigator was Dr. James G. Holland of Harvard University. The program was the well-known *The Analysis of Behavior,* co-authored by Dr. Holland and Professor B. F. Skinner.

In a paper read to the American Psychological Association convention in 1960, Dr. Holland said: "The programer's only contact with the student is in the student's response, hence *the portion of the item left for the student to complete is an extremely important choice which, faces the programer.* All the various aspects of programing require that the student give the response for the right reason. The response required of the student is often chosen only to assure that the critical content of the item or perhaps a panel is carefully read or observed.

For example, success in answering the problem may serve only to assure the student's careful observation of the material in front of him at the moment. A term may be defined in the first part of an item and an example given in the remainder of the item requiring a response which can be given only if the definition has been carefully read. . . . The choice of the word to be left blank for the student to provide is not arbitrary. It must be one which assures that he notice the critical material which that item is supposed to teach."

A further criterion for choosing the response was that "the student should be able to answer the item correctly". This part of Dr. Holland's research will be discussed at a later date.

Items from thirteen lessons of the Holland-Skinner program were rewritten to demonstrate the principle that students should respond to *critical* information. No changes were made in the information content. The sole change lay in the response the student was required to give.

For example, in Lesson 9, item 2 introduces a key term. The information part of the item reads: **A technical term for "reward" is reinforcement.** The critical information is obviously the new term.

According to the "recipes" offered by all programers, the student learns what he is led to do, and, if he is to learn 'reinforcement,' he should make some response to this term. Following this procedure, the original item in the true version of the program reads: **A technical term for "reward" is reinforcement. To "reward" an organism with food is to _____ it with food.** As given, the item requires the student to attend to the new term.

The faulty version, as deliberately butchered by Dr. Holland reads: **A technical term for "reward" is reinforcement. To "reward" an organism with food is to reinforce it with _____.**

In this version, the student is not required to attend to the new term. The programer has no "written guarantee" that the student has read the word at all. A longer illustration of this type of noncritical response is provided in parallel with the true version.

True version: Lesson 11

1. **A stimulus which follows a response is called a _____ if the rate at which similar responses are emitted is observed to increase. (Answer: reinforcer)**
2. **A hungry pigeon pecks a key and is immediately given food. The _____ of pecking will increase since presenting food _____ a reinforcement. (Answer: rate, is)**
3. **If, instead of presenting food after the pigeon pecks the key, a loud noise is turned on, the rate of pecking will not increase. Presenting a loud noise _____ a reinforcement. (Answer: is not)**
4. **When pecking a key turns off a very loud noise for a few moments, the frequency of pecking in the presence of the noise is observed to increase. Ending the loud noise _____ a reinforcement. (Answer: is)**
5. **Reinforcement which consists of presenting stimuli (e.g., food) is called positive reinforcement. In contrast, reinforcement which consists of terminating stimuli (e.g., painful stimuli) is called _____ reinforcement. (Answer: negative)**
6. **Turning off a television commercial is reinforced by the termination of the _____ reinforcer; turning on a very funny program is reinforced by the presentation of a _____ reinforcer. (Answer: negative, positive)**
7. **A stimulus is called a negative reinforcer if it reinforces the behavior which _____ it. (Answer: terminates)**
8. **Elimination of a television commercial may be a negative reinforcement. The television commercial is a _____ _____. (Answer: negative reinforcer)**
9. **If a funny program is a positive reinforcer, presenting the program is a _____ _____ (Answer: postive reinforcement)**
10. **The rate of an operant can be increased by presenting a _____ _____ or by ending a _____ _____. (Answer: positive reinforcer, negative reinforcer)**

The critical content of the lesson presented here is obviously the common properties of and the differences between the operations called "positive reinforcement" and "negative reinforcement." (The reader should not be disturbed if he finds the good version difficult; it is well along in the program and assumes a good deal of previous learning.) The true version of the program requires the student to make responses relevant to these concepts.

The faulty version contains some clever parodies of items, such as requiring a sophisticated student to respond "pigeon" and "key" (no. 3), or "commercial" and "television" (no. 8).

Some of the items are less obviously noncritical responses. In items 1, 5, and 7, the responses are technical terms, but these responses can be given on the basis of previous learning by a student who does not understand the distinction between negative and positive reinforcement. Most of the items can be answered by a good reader on the basis of their grammar alone, with no understanding required.

Faulty version: Lesson 11

1. A stimulus which follows a response is called a reinforcer if the rate at which similar _____ are emitted is observed to increase. (Answer: responses)
2. A hungry pigeon pecks a key and is immediately given food. The rate of pecking will increase since presenting _____ is a reinforcement. (Answer: food)
3. If, instead of presenting food after the _____ pecks the _____, a loud noise is turned on, the rate of pecking will not increase. Presenting a loud noise is not a reinforcement. (Answer: pigeon, key)
4. When pecking a key turns off a very loud noise for a few moments, frequency of pecking in the presence of the noise is observed to increase. Ending the loud _____ is a reinforcement. (Answer: noise)
5. Reinforcement which consists of presenting stimuli (e.g., food) is called positive reinforcement. In contrast, reinforcement which consists of terminating _____ (e.g., painful stimuli) is called negative reinforcement. (Answer: stimuli)
6. Turning off a television commercial is reinforced by the termination of the negative reinforcer; turning on a very funny program is _____ed by the presentation of a positive reinforcer. (Answer: reinforced)
7. A stimulus is called a negative reinforcer if it _____ behavior which terminates it. (Answer: reinforces)
8. Elimination of a television _____ may be a negative reinforcement. The _____ commercial is a negative reinforcer. (Answer: commercial, television)
9. If a funny _____ is a positive reinforcer, presenting the program is a positive reinforcement. (Answer: program)
10. The rate of an operant can be increased by presenting a positive reinforcer or by ending a negative _____. (Answer: reinforcer)

It should be noted that the error rate found by Dr. Holland on the faulty version was less than half that found on the true version. An item which can be answered on the strength of its grammatical structure is not as difficult as an item which requires understanding of the material. A reduction in error rate is desirable if it is not accompanied by a reduction in acquisition. In terms of the final performance of the students on a test of their knowledge, the results strongly favor those students who were required to interact with the critical aspects of material.

In the last issue of the Bulletin, this column discussed the effects of sequencing on the error rate and on final achievement. Evidence reported there suggested that low error rates are not always reflected in superior performance on a final test. Dr. Holland's data support this conclusion. Again, overdependence on grammar and underdependence on understanding lead to poor final performance. Correct responses are valuable only when the student has been led to do what the programer wishes to teach him. In Dr. Holland's words: "Items must be so written that the ability to correctly answer the item *depends* on noticing the critical information in the item." Programers should get from the student a "written guarantee" that he understands. Evidence that he reads English is not enough.

SUSAN MEYER MARKLE

—o—

EXPERIMENTATION WITH PROGRAMED INSTRUCTION

(Continued from page 3)

problems exist, of course, in *all* instructional situations; programing makes them inescapable.

Careful observation of a class using a programed unit provides an opitimal way of discovering what programed instruction is. Many teachers will also find the record of each student's results an excellent basis for diagnosing his individual learning difficulties.

Consumers must be able to assess the quality of programs for themselves. If the publisher has presented data about the efficacy of the program, the consumer can compare his results with those of the publisher's. Some school systems are already involved in field testing programs in cooperation with programers and publishers who are developing and refining programs.

To aid school personnel interested in systematic exploration of some of the problems in the field the Center will hold weekly seminars to discuss experimentation with and implementation of programs. (See announcement, page 8.)

The experimental approaches discussed in this article explore programed instruction under conditions that seek to minimize the influence of the teacher, thus allowing the program to demonstrate what it can do on its own.

In the next issue of the Bulletin we will discuss implementation studies which try to answer the question, "How can a teacher use programs most effectively?

LASSAR GOTKIN

RING OUT (Continued from page 1)

able" student and parent reaction to the materials. "When we searched for negative reactions we could find very few; the students have, however, suggested greater use of demonstrations and experiments to parallel the texts."

To all those who have visited the Center during the past year, assisted with research and field trials, participated in our workshops, sat through our speeches, read our written symbols, provided "stimuli" letters, the following would like to say, Thank you, and to send you best wishes for the holiday season.

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Seminar On Programed Instruction

To assist persons interested in experimenting with programed instruction, the Center's research staff will hold an informal seminar every Thursday afternoon from 3 to 5 o'clock. School administrators, teachers, graduate students, and others seeking guidance in the experimental investigation of programed instruction are invited to attend.

Attendance at the seminar will be limited to 10 people. Interested persons are, therefore, advised to contact Mrs. Sally Thompson at the Center for Progra[illegible], 365 West End Avenue, [illegible]ork City 24, Trafalgar 3-7684, for an appointment. Please specify the date or dates you can attend and the nature of the problem you wish to investigate.

RECENT RESEARCH

(Continued from page 5)

that they would. Their classroom teacher reported that they looked forward to the program each day.

Comment:

The results of this study are quite encouraging. It is interesting to note that in this study a multiple-choice technique was used effectively. The authors' method of testing the children may be a significant contribution to this field in which the testing of very young children creates considerable problems. This supports the findings reviewed in this bulletin, as well as findings in a number of other studies involving subjects who could read and write.

RESPONSES

(Continued from page 2)

Even though a teacher understands the material and uses good methods in presentation, a teacher seldom has both time and the extensive knowledge to produce an effective program. The suggestions of an experienced teacher are valuable and should be incorporated in revisions of the program.

Loetta W. Horton

I do feel that the basic work in preparing the programs, done by subject matter specialists, followed by teacher's comments made after using the material, is much better than having high school teachers prepare their own programs.

A subject matter specialist knows better than most high school teachers exactly what the pupil has to contend with beyond the high school in that particular subject and can see that all necessary background material has been included.

Also, the subject matter specialists are closer to the fields where that particular subject will be put into use, while the heavy schedules most high school teachers carry does not allow much time for research.

The specialist, I feel, by making the tests, stresses important facts at the most effective points, and by stating where each particular test should be given, helps the teacher.

Florence Tucker

More Recent Research . . . .

The road to Serendip is paved with many a slip. Noel Korn of Valley College in California reminds us that Horace, not Hugh Walpole, deserves credit for sending the princes to Serendip as cited in the October issue.

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